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Enhancing groundnut (*Arachis hypogaea* L.) productivity through foliar nutrition

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Abstract: A field experiment was conducted during *kharif* 2013 to study the foliar nutrition in groundnut (*Arachis hypogaea* L.) at Main Agricultural Research Station, Dharwad under rainfed situation. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and ten foliar treatments of major nutrients. The yield attributes such as 100 pod weight (117.65 g), total number of pods plant^{-1} (28.37), 100 kernel weight (42.19 g), pod yield (3746 kg ha^{-1}), kernel yield (2905 kg ha^{-1}) and haulm yield (4253 kg ha^{-1}) were higher in foliar spray of 2.0% urea + DAP + MOP combination (T_8). Similarly, growth parameters such as leaf area (8.90 dm^2 plant^{-1}), leaf area index (2.97), total dry matter production (40.22 g plant^{-1}), net returns (₹108730 ha^{-1}) and B:C (4.12) were the highest in foliar spray of 2.0% urea + DAP + MOP combination at 45 DAS followed by foliar spray of 19:19:19 (₹108095 ha^{-1} and 4.12, respectively).

Keywords: Foliar spray, Groundnut, Major nutrients, Pegging, Pod yield

Introduction

Among oilseed crops groundnut is an important crop grown in tropical and sub tropical regions in the world for vegetable oil. It is the most versatile legume because of drought tolerant characters, soil restoring properties, weeds smothering, multi-purpose confectionary and dilatory uses. As a legume oil yielding crop, it fits well into most of the cropping systems. Commercially, groundnut is the world's fourth most important sources of edible oil and third most important sources of vegetable protein. The groundnut crop is grown over an area of 26.62 million ha spread over 84 countries with an annual production of 35.66 million tonnes pods with a productivity of 1348 kg ha^{-1}. In India, it is being grown in 11 states in an area of 4.19 million ha with a production of 5.62 million tonnes of pods per annum. The average productivity of groundnut in India (1341 kg ha^{-1}) can be comparable to world average (Anon., 2013).

The low groundnut productivity in Karnataka could be attributed to several production constraints, which include poor and imbalanced nutrition and cultivation in marginal lands. Therefore, it is most essential to pay a great attention to the nutrition of groundnut to enhance its productivity. Foliar feeding practice would be more useful in exhaustive crop like groundnut. Foliar nutrition reduces the amount of fertilizer thereby reducing the loss and also economizing crop production. Crop nutrition through foliar feeding at particular stage may solve the slow growth and low seed yield of legumes without involving root absorption at critical stages. Among the macronutrients, nitrogen is a major structural component of the plant cell. It plays an important role in plant metabolism and is involved in synthesis of proteins, amino acids and nucleic acids. Phosphorus is essential for the formation of protoplasm, cell division and development of meristematic tissues, hastens nodule formation. Potassium plays an important role in enzyme activation, provides turgidity to plants, translocation of assimilates, photosynthates, proteins, starch synthesis besides improving the quality of the produce.

Foliar nutrition can help to maintain a nutrient balance within the plant, which may not occur strictly with soil uptake (Meena *et al.,* 2007). The effectiveness of foliar applied nutrients is determined by the type of formulation and the time of application. Foliar spray stimulates an increase in chlorophyll production, cellular activity and respiration. It also triggers a plant response to increased water and nutrient uptake from the soil (Veeramani *et al., 2012).*

Hence, it is feasible, economically viable and environment friendly approach of nutrient management and a need was felt to optimize the foliar application of all macro nutrients along with recommended doses of nutrient application through soil for nutritionally hungered soils of groundnut belt of Karnataka

Material and methods

A field experiment was conducted at Main Agricultural Research Station Dharwad during *Kharif* 2013. The soil was texturally clay, neutral in pH, non saline (0.61 dSm^{-1}), medium in organic carbon (0.73%), low in available nitrogen (213.8 kg N ha^{-1}), medium in available phosphorus (34.22 kg P_2O_5 ha^{-1}) and high in available potassium (391.30 kg K_2O ha^{-1}). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and ten foliar treatments of major nutrients *viz.,* foliar sprays of 1.5% Urea, 2.0% Urea, 1.5% DAP, 2.0% DAP, 1.5% MOP, 2% MOP, 1.5% Urea: DAP: MOP (0.5% of each), 2.0% Urea: DAP: MOP (0.7% of each), 0.5% 19 All (19:19:19 N:P_2O_5:K_2O) and control. Genotype TAG-24 was used in the study. Recommended fertilizers (25:75:25 kg N: P_2O_5:K_2O) were applied in the form of Urea, DAP and MOP as basal at the time of sowing for all the treatments uniformly. Further Zinc sulphate @ 25 kg ha^{-1} and ferrous sulphate @ 25 kg ha^{-1} were applied to soil along with FYM @ 7.5 t ha^{-1} before sowing for all the treatments. Gypsum @ 500 kg ha^{-1} was also applied all the treatments at root zone of groundnut at 40 DAS through last intercultivation. Five plants from net plot area were randomly selected and observations on growth and yield parameters were recorded at 30, 60, 90 DAS (days after sowing) and at harvest. At harvest, yield and its components such as 100 pod weight, 100 kernel weight, number of pods plant^{-1}, pod yield, kernel yield and haulm yield were determined.

Result and discussion

Significant differences were observed in pod yield of groundnut as a consequence of foliar feeding of major nutrients. The maximum dry pod yield was observed in the foliar spray of 2.0% urea + DAP + MOP combination (T_8: 3746 kg ha^{-1}) and was higher to an extent of 16.28% compared to control (T_{10}: 3136 kg ha^{-1}). However, it was on par with all other treatments (3447 to 3723 kg ha^{-1}) except foliar spray of 1.5% MOP (T_5: 3337 kg ha^{-1}) (Table 3). The present results are in close proximity with the findings of Veerabhadrappa and Yeledhalli, 2005, and Chandrasekaran *et al.* (2008).They reported that foliar application of major nutrients recorded significantly higher pod yields especially when groundnut grown under rainfed condition. There was significant correlation between nutrient uptake and pod yield. The flowering in groundnut started at 35-45 DAS and followed by peg initiation at 10-12 days after flowering. Therefore groundnut needs greater quantity of major nutrients to meet the demand of developing pods. Spraying of DAP helped in quick absorption of nitrogen and phosphorus at the time of reproductive stage where the nutrient demand is at the peak. Hence, it reduces the flower drop and ultimately enhanced the pegging and pod development. These results are in conformity with the findings of Dalei *et al.* (2014).

In addition, foliar feeding of major nutrients especially N resulted in development and maintenance of more chlorophyll and photosynthetic area in terms of higher leaf area and leaf area index which resulted in higher photosynthesis. Foliar feeding of K helps in higher translocation of photosynthates from leaves to the developing pods and resulted in more pods to gynophores ratio. These two factor combined together increased the photosynthates trasnslocated to developing pods and resulted in development of sound and mature kernels and hence the foliar spray of 2.0% Urea + DAP+ MOP combination recorded significantly higher kernel yield (T_8: 2905 kg ha^{-1}) compared to control (2339 kg ha^{-1}), foliar spray of 1.5% urea (2636 kg ha^{-1}), 2% MOP (2607 kg ha^{-1}) and foliar spray of 1.5% MOP (2516 kg ha^{-1}). While remaining foliar treatments produced on par kernel yield as that of foliar spray of 2.0% Urea + DAP+ MOP. Similar results were also obtained in black gram with application of RDF + foliar spray of 40ppm NAA + 0.5% chelated micronutrient by Shashikumar *et al.* (2013). The variation in pod yield of groundnut could be traced back to variations in yield parameters. The pod yield is governed by a number of factors having direct or indirect influence. The main factors which have direct bearing on pod yield are total number of pods plant^{-1}, 100 pod weight, 100 kernel weights and shelling percentage.

Among the yield components, 100 pod weight was more closely associated with the dry pod yield ha^{-1}. Foliar spray of 2.0% urea + DAP + MOP combination produced higher number of pods plant^{-1} (28.37) which was 15.54% more than control (23.96), while it was on par with foliar spray of 19:19:19 (T_9: 28.15) and 1.5% urea + DAP + MOP (28.00). Significant positive correlation between yields attributes and pod yield was observed. The increased number of pods per plant was mainly attributed to increased pod to gynophore ratio because of supply of required demand of photosynthates to developing pods and hence sustains the more number of pods plant^{-1}. The similar observations were made by Naveen Kumar (2012), who noticed that basal application of NPK along with foliar spray of urea at 45 DAS recorded improvement in yield components such as number of pods plant^{-1}, pod dry weight, 100 pod weight and higher 100 kernel weight. However, all foliar spray treatments were on par with each other except 1.5% foliar spray of MOP. Application of recommended dose of fertilizers along with foliar application of nutrients at critical stages boosted the growth and yield components (Chandrasekaran *et al.,* 2008).

Similarly, 100 kernel weight (42.19 g) was higher in foliar spray of 2.0% urea + DAP + MOP combination and were higher to an extent of 20.76% over control. However, it was on par with foliar spray of 19:19:19 (T_9: 40.58 g), 1.5% urea + DAP + MOP (T_7: 40.56 g), 2% DAP (T_4: 40.25 g), 2% urea (T_2: 39.75 g) and 1.5% DAP (T_3: 38.81g) (Table 2). Improved 100 kernel weight under above foliar treatments was mainly because of increased translocation of photosynthates from leaves and stem to developing pods resulted in sound mature pods and bolder seeds. Also it was evident from the data on leaf area duration that these foliar feeding treatments maintained the leaf area for longer duration resulted in extended period of photosynthates translocated to developing seeds and hence recorded bolder and well shaped seeds. Similar differences with respect to yield components were also reported earlier by Chandrasekaran *et al.,* (2008).

Pod weight plant^{-1} was greatly influenced by dry matter accumulation in pods. The higher number of pods plant^{-1} was due to the fulfillment of the demand of the crop by higher assimilation and translocation of photosynthates from source to sink. In addition foliar feeding of major nutrients especially phosphorous resulted in development of sound pod wall and as a consequence, significantly higher pod weight plant^{-1}and increased seed filling capacity. Similar influence of phosphorus and PSB+VAM on pod development and its filling capacity was reported by Lingaraj *et al.,* (2016).

The morphological characters (plant height, number of branches plant^{-1} and leaf area) differed due to foliar application of fertilizers. Foliar spray of 2.0% urea + DAP + MOP combination produced taller plant (23.94 cm) and more number of branches (8.94 plant^{-1}) at harvest compared to control (19.62 cm and 6.82, respectively). It was on par with all other foliar treatments except 1.5% MOP (20.76 cm and 7.46 plant^{-1}, respectively (Table1). The combined spray of N, P and K resulted in greater mobilization of macro nutrients as reported by Manasa (2013).

The pod yield is an end product, which obviously depends upon the total dry matter production at different stages of crop growth and its partitioning into reproductive parts for higher production. Foliar spray of 2.0% urea + DAP + MOP combination produced significantly higher total dry matter plant^{-1} at harvest (40.22 g plant^{-1}) and it was 22.9% more compared to control (30.99 g plant^{-1}). However, it was on par with foliar spray of 19:19:19 (T_9:

Table 1. Growth parameters of groundnut at harvest as influenced by foliar spray of major nutrients

Treatment	Plant height (cm)	Number of branches ($plant^{-1}$)	Leaf area (dm^2 $plant^{-1}$)	Leaf area index	Total dry matter (g $plant^{-1}$)
T_1 - Foliar spray of 1.5% urea	22.23	6.72	7.91	2.64	37.31
T_2 - Foliar spray of 2.0% urea	22.67	6.93	8.05	2.68	38.02
T_3 - Foliar spray of 1.5% DAP	23.03	6.84	7.95	2.65	37.52
T_4 - Foliar spray of 2.0% DAP	23.57	7.22	8.40	2.80	38.53
T_5 - Foliar spray of 1.5% MOP	20.76	6.34	7.40	2.47	34.59
T_6 - Foliar spray of 2% MOP	21.87	6.60	7.71	2.57	36.66
T_7 - Foliar spray of 1.5% urea: DAP: MOP (0.5% of each)	23.36	7.18	8.08	2.69	39.72
T_8 - Foliar spray of 2.0% urea: DAP: MOP (0.7% of each)	23.94	7.82	8.90	2.97	40.22
T_9 - 0.5% foliar spray of 19:19:19 N: P_2O_5: K_2O	23.71	7.46	8.67	2.89	39.87
T_{10}- Control	19.62	5.57	6.38	2.13	30.99
S.Em±	0.70	0.36	0.45	0.15	0.86
C.D. at 5%	2.09	1.07	1.34	0.45	2.55

Table 2. Yield parameters of groundnut as influenced by foliar spray of major nutrients

Treatment	Number of pods $plant^{-1}$	100 pod weight (g)	Shelling (%)	100 kernel weight (g)
T_1 - Foliar spray of 1.5% urea	26.28	108.21	75.74	37.68
T_2 - Foliar spray of 2.0% urea	27.32	108.41	76.60	39.75
T_3 - Foliar spray of 1.5% DAP	26.96	109.26	76.64	38.81
T_4 - Foliar spray of 2.0% DAP	27.64	110.67	77.11	40.25
T_5 - Foliar spray of 1.5% MOP	25.91	103.44	75.39	35.96
T_6 - Foliar spray of 2% MOP	26.55	104.61	75.63	37.26
T_7 - Foliar spray of 1.5% urea: DAP: MOP (0.5% of each)	28.00	114.10	77.03	40.56
T_8 - Foliar spray of 2.0% urea: DAP: MOP (0.7% of each)	28.37	117.65	77.49	42.19
T_9 - 0.5% foliar spray of 19:19:19 N: P_2O_5: K_2O	28.15	115.52	76.85	40.58
T_{10} - Control	23.96	102.20	74.55	33.43
S.Em ±	0.76	3.30	1.07	1.24
C.D. at 5%	2.25	9.81	NS	3.68

NS = Non significant

Table 3. Dry pod yield and economics of groundnut as influenced by foliar spray of major nutrients

Treatment	Dry pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (HI)	Net return (₹ ha^{-1})	B:C
T_1 - Foliar spray of 1.5% urea	3482	2636	3998	0.36	98879	3.85
T_2 - Foliar spray of 2.0% urea	3632	2781	4096	0.36	104560	4.02
T_3 - Foliar spray of 1.5% DAP	3541	2715	4030	0.36	100903	3.90
T_4 - Foliar spray of 2.0% DAP	3682	2839	4177	0.36	106176	4.04
T_5 - Foliar spray of 1.5% MOP	3337	2516	3816	0.34	93251	3.68
T_6 - Foliar spray of 2% MOP	3447	2607	3988	0.35	97374	3.80
T_7 - Foliar spray of 1.5% urea: DAP: MOP (0.5% of each)	3692	2838	4196	0.36	106729	4.07
T_8 - Foliar spray of 2.0% urea: DAP: MOP (0.7% of each)	3746	2905	4253	0.36	108730	4.12
T_9 - 0.5% foliar spray of 19:19:19 N: P_2O_5: K_2O	3723	2862	4223	0.36	108095	4.12
T_{10}- Control	3136	2339	3718	0.34	86029	3.50
S.Em ±	104.08	71.9	90.15	0.008	3955	0.11
C.D. at 5%	309.26	213.6	267.85	NS	11751	0.34

NS = Non significant

39.87 g $plant^{-1}$), 1.5% urea + DAP + MOP (T_7: 39.72 g $plant^{-1}$), 2% DAP (T_4: 38.53 g $plant^{-1}$), 2% urea (T_2: 38.02 g $plant^{-1}$), 1.5% DAP (T_3: 37.52 g $plant^{-1}$),1.5% urea (T_1: 37.31 g $plant^{-1}$) and 2% MOP (T_6: 36.66 g $plant^{-1}$) (Table 1) The improvement in the dry matter production may be due to the instant assimilation of nutrients supplied through the foliar application meeting the required nutrient demand of the crop during flowering period of groundnut. Foliar application resulted in greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Increased production of dry matter and its efficient translocation to its economic parts ultimately reflected on the final pod yield. The role of foliar application of nutrients on physiology of crop plants is well established. Therefore, better availability and uptake of nutrients could be assigned as the proper reason behind the significant increase in dry matter production and its accumulation in foliar spray treatments. The similar observations were made by Shivakumar Malladada (2005) and Dalei *et al.* (2014).

Conclusion

From the above investigations it can be inferred that groundnut requires higher amount of nutrients during pegging and pod development stages. Foliar application of 2.0% urea + DAP + MOP at 45 days after sowing improved the growth, pod yield (3746 kg ha^{-1}), kernel yield (2905 kg ha^{-1}) and haulm yield (4253 kg ha^{-1}) compared to unsprayed control.

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